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A review of emotion deficits in schizophrenia

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Although many different definitions of emotion have been advanced, most current researchers do not consider emotions as a unitary, elementary entity, but rather view them as a multicomponent phenomenon.^{1,2} Emotions are defined as a complex of changes in the various subsystems of the organism's functioning. The components of emotion include: (i) antecedent events; (ii) appraisal; (iii) emotional experience; (iv) physiological changes; (v) change in motivational states; (vi) expression and behavior; (vii) change in cognitive functioning and beliefs; and (viii) regulatory process.

“Emotional antecedents” refer to the external or internal events (acts or thoughts) that precede and lead to an emotion in an individual. The concept of emotional antecedent is tied to the concept of emotion appraisal. “Appraisal of an emotional event” refers to the perception and the subjective evaluation for the subject's own

Emotion deficits in schizophrenia have been described since the time of Kraepelin. However, no comprehensive review of clinical emotion studies has ever been conducted. In this work, studies that used diagnostic criteria and were published in English were selected from an extensive PubMed search. Fifty-five studies on emotion expression repeatedly showed that individuals with schizophrenia (IWSs) display fewer overt expressions than nonpatient comparison subjects (NCSs) in verbal, facial, and acoustic channels. No clear differences were found between IWSs and depressed subjects. Sixty-nine studies examined emotion experience in schizophrenia. IWSs report higher anhedonia, and they tend to show more negative emotions in real-life event studies. In evocative studies, they report a similar degree of pleasantness and a similar or higher degree of unpleasantness. From 110 studies, it can be concluded that emotion recognition is impaired in schizophrenia in all channels. These deficits in social perception are correlated with neurocognitive deficits and some social skills. IWSs show dysfunction in the three domains of emotion expression, emotion experience, and emotion recognition, and these dysfunctions appear to be independent of each other across domains. These deficits in basic emotion processing may be linked to psychopathology and functional outcomes.

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Selected abbreviations and acronyms

ANS	<i>autonomic nervous system</i>
IWS	<i>individual with schizophrenia</i>
NCS	<i>nonpatient comparison subject</i>
PAS	<i>Physical Anhedonia Scale</i>
SAS	<i>Social Anhedonia Scale</i>

well-being of the emotional properties of the event. Therefore, an event is an emotional antecedent insofar as it has been appraised as being emotional by an individual. Appraisal is a central concept in emotion theory to the point that, for some cognitive appraisal theorists,³ emotions are the results of a set of appraisals.

Studies have examined emotions following two major approaches: a dimensional or a categorical approach. The first approach is bimodal, in which emotions are considered as pleasant/positive or unpleasant/negative. In the categorical approach, discrete emotions are studied, such as anger, disgust, fear, happiness, sadness, and surprise. Research in schizophrenia has looked extensively at some components of emotion, while paying little attention to other components. In schizophrenia, three domains of emotion have been extensively studied: expression of emotions; experience of emotions (feelings); and recognition of emotions. These three domains do not encompass all emotion components described above, and may refer to different concepts. For example, the recognition of emotion should not be confused with the appraisal process. In emotion recognition studies, participants are asked to recognize the emotions expressed by other people, whereas in appraisal studies, participants are asked to report their subjective evaluation, ie, the emotion they experienced from a stimulus. Concretely, there is a big difference between the ability to recognize that a face is expressing disgust (emotion recognition), and finding a face disgusting (subjective appraisal). Similarly, facial expressions of anger most often induce fear (appraisal and experience) and not anger in viewers. It can be said that emotion recognition is part of emotional intelligence and social perception, whereas appraisal is part of emotion processing.

Methods

We conducted a broad PubMed search and added cross-references. We only selected experimental studies that were published in English and used diagnostic criteria. Studies that combined patients with schizophrenia and

patients with schizoaffective disorder were also included. Neuroimaging and electrophysiological studies on emotion recognition or experience were included, provided they reported on patients' test performances. However, we will not report or discuss neuroimaging data or electrophysiological findings in this review. A list of the studies reviewed is available from the author on request.

Three broad categories were defined. Studies on *emotion expression* included covert and overt expressions, expressions from skeletal muscle activity, and expressions from the autonomic nervous system (ANS). Studies on *emotion experience* were studies on the conscious experience of emotions, using patients' self-reports or self-evaluations in order to categorize the emotion. Studies on *emotion recognition* were studies on the conscious recognition/perception of the emotional valence of an external stimulus.

In this article, we report on the main differences between individuals with schizophrenia (IWSs) and nonpatient comparison subjects (NCSs), and between IWS and depressed subjects.

Results

Emotion expression

Fifty-five studies qualified as emotion studies.

Verbal expression

Two different questions should be studied:

- Do IWSs use similar concepts and words to NCSs when referring to emotions?
- Do verbal variables differ between IWSs and NCSs when they talk about their emotions?

Studies found that IWSs have a similar understanding of emotion words, and they use the same semantic affective structures as NCSs.⁴ Therefore, IWSs have a comparable semantic knowledge of emotions to NCSs. Regarding verbal output, the only difference was in word counts: IWSs use fewer words than NCSs when they describe emotional situations.⁵

Facial expression

The face is certainly the most expressive and specific part in the body where emotions are expressed. Ekman⁶ and Izard⁷ have shown that some emotions have cross-cul-

tural expressions, and they have developed rating scales for facial emotional expressions. The results of their research were incorporated into schizophrenia research. Facial expressions can be divided into two types: voluntary/posed and involuntary/spontaneous expressions, with the presumption that these two types of expressions use two different neurological pathways.

When compared with NCSs, 13 studies reported that medicated or unmedicated IWSs are less expressive, in frequency and intensity, for posed and spontaneous emotional expressions and for all emotions, and that this deficit is stable over time. Three studies reported contrasting results, and four studies did not find any significant differences in expressiveness between IWSs and NCSs.⁸⁻¹¹

Studies have also compared IWSs with depressed patients. Most studies (n=6) did not find any significant differences between these two groups. Two studies^{12,13} selected schizophrenia patients with blunted affect, and reported decreased expressions in the schizophrenia group. Three studies reported a higher level of expressiveness in schizophrenia.^{5,8,14,15}

Surprisingly, some studies^{11,16-20} could not find any correlations between emotional expressions and clinical ratings of blunted affect.

Acoustic expression

The voice can convey affective signals.²¹ Among emotions, disgust is poorly recognized and happiness is not easily recognized, while anger, interest, and boredom are highly recognizable. The most significant parameters involved in emotional speech are pitch, voice intensity, and speech rate. However, it is not clear to what extent the variations in these acoustic parameters fully explain the human encoding processes and decoding capacities. As for facial expressions, vocal expressions can be divided into spontaneous and voluntary expressions. In voluntary expressions, subjects are asked to read sentences with a specific emotional tone. For spontaneous expressions, subjects are asked to report an emotional event.

The first question is whether IWSs express emotions as well as other groups. Five studies^{12,22-25} found that IWSs were less accurate in spontaneous and voluntary emotion expressions, while, in one study,²⁶ positive schizophrenia patients were more accurate than NCSs. IWSs were less accurate than depressed patients in two studies, while positive schizophrenia patients were more accurate than depressed patients in a third study.²⁶

The second question is: which acoustic parameters are involved in this deficit? From comparative studies with NCSs, it seems that various acoustic parameters interplay in these deficits, including duration of utterance, fluency, intonation, variations in loudness and pitch, and pauses. All these acoustic parameters are also impaired in neutral speech in schizophrenia, and may reflect impairment in global prosody.

In one study,²⁷ acoustic measures were also compared with clinical ratings.¹ The acoustic measure of percentage of time talking was not correlated with the Global Rating of Alogia. Acoustic measures of pitch were not correlated with the Scale for the Assessment of Negative Symptoms (SANS) item, lack of vocal inflection. The acoustic measure of response latency was not correlated with the SANS item, increased latency of response. This underlines the difficulty of giving a precise clinical rating to these acoustic items, and Alpert et al²⁷ came to the conclusion that ratings of negative symptoms are influenced by an undifferentiated global impression.

Automatic recordings

Computer analyses and electromyography (EMG)²⁸ have been used to record facial muscle actions. Although these kinds of analysis cannot predict which emotion is expressed, they can detect observable and unobservable facial muscle activity, and authors estimate that most of the facial behavior recorded by EMG corresponds to subtle, covert muscular activity. Some authors²⁹ have hypothesized that covert facial expressions are a rudimentary emotional reaction, while a higher intensity is required to produce overt facial emotional expressions. Two facial muscles have been particularly studied: the zygomaticus major muscle, whose action draws the end of the mouth up and back (recorded at lip corners), and the corrugator supercilium muscle, whose action draws the brows together (recorded above the brows). The zygomatic muscle is involved in smiles, while the corrugator muscle is involved in most negative facial emotional expressions. It should also be kept in mind that nonemotional components, such as effort, concentration, and puzzlement, are known to increase corrugator activity.

Four studies^{10,28,30,31} recorded the zygomatic activity during induced positive emotions, and three reported a lower EMG activity in schizophrenia. These studies are consistent with the idea that IWSs smile less frequently than NCSs.

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Concerning corrugator activity, two EMG studies found no differences between IWSs and NCSs during pleasant activity. During negative affect conditions, one study³⁰ reported similar corrugator activity between groups, whereas three other studies reported an increase in corrugator activity when compared with NCSs.

Compared with depressive groups, one study⁸ found no difference in overall computerized facial muscle activity. In another study,³² mean muscle activity was grouped across emotions, and no difference between IWSs and depressed subjects with psychotic features were found for the zygomatic and corrugator muscles.

Few studies examined the influence of antipsychotic medications, and most studies could not find a significant influence of medications in EMG recordings. However, a recent study³³ reported less zygomatic activity in unmedicated patients than in NCSs, and a decrease in smiling activity when IWSs were treated with risperidone, but not with olanzapine.

Autonomic nervous system

Some physiological manifestations of emotions, such as increased heart rate, perspiration, hot face, faster respiration, dry mouth, and increased urination are expressed through the ANS. Although some authors reported emotion-specific ANS response patterns, replications did not follow, and emotion-specific ANS response patterns have been considered as unreliable.

Skin conductance. Skin conductance has been the most frequently physiological measure used to evaluate ANS response to emotions. Skin conductance is under sympathetic control, is correlated with the number of eccrine sweat glands, and is sensitive to a large range of stimuli, including emotional arousal.³⁴

Compared with NCSs, IWSs showed similar (four studies) or higher (one study) skin conductance reactivity in positive conditions, and similar (five studies) or higher (two studies) skin conductance reactivity in negative conditions. It should be noted that IWSs have shown more skin conductance reactivity even with neutral stimuli in two studies.^{31,35}

A thorny issue concerns medication status. Acetylcholine, norepinephrine, and dopamine are neuromediators involved in the ANS,³⁶ and it has been shown that antipsychotic medications have an impact on skin conductance. Therefore, it has been thus recommended to conduct psy-

chophysiological studies with unmedicated patients only. Among the studies just reviewed above, only two used unmedicated patients, and one of them³⁷ reported a higher skin conductance for positive and negative conditions.

Cardiovascular system. Other studies^{32,38-40} looked at cardiovascular reactivity (heart rate and blood volume) to emotional stimuli. The results have been mixed. Some studies found no differences between groups, a decreased finger pulse volume reactivity, or different time-response curves for heart rate variability in schizophrenia.

Conclusions: emotion expression

It thus appears that expression studies in schizophrenia research can be divided into two broad categories: emotion expressiveness and emotion reactivity. Emotion expressiveness includes controlled expressions with an intentional component and their social, communicative value is evident. Expressiveness encompasses verbal output and overt facial expressions. Emotion reactivity contains an idea of automaticity or covert expressions. Covert facial muscle activity and ANS reactions can be placed in this category.

IWSs show deficits in emotion expression in verbal, facial, and acoustic channels. Mandal et al⁴¹ reviewed 11 studies from 1970 to 1996 on facial expressiveness, and came to the conclusion that deficits exist in emotion expression.

Deficits in facial and acoustic expressions were found for posed and spontaneous expressions, suggesting a motor deficit. Moreover, the impairments observed in these two channels correlate with each other and seem to be part of broader deficits in expressiveness.⁵ They may reflect a deficit in a premotor brain area involved in social and emotional expressions, such as the anterior cingulate area. The detrimental effect of deficits in expressiveness on social functioning and outcomes is an avenue of research. Although there is some evidence that impaired emotion expression in schizophrenia has detrimental social consequences, this issue awaits confirmation. It is quite conceivable that deficits in expressiveness contribute to the stigma encountered by IWSs.⁴²

Reactivity studies have brought contrasting results, and some studies have shown valence specificity. Overall, it can be concluded that emotion reactivity is not reduced in schizophrenia, and appears to be increased in specific conditions.

Emotion experience

Sixty-nine studies on emotion experience were reviewed. Emotion experience studies can be categorized according to the type of antecedents (ie, emotional events) that they use: fixed stimulus in a laboratory setting or real-life emotion antecedents. In the first type of studies (evocative studies), the same emotional stimulus is presented to all participants, and they report on their emotional experience after exposure to the stimulus. In the second type of studies (life-event studies), subjects are asked to evaluate events that happened during their lives. In life-event studies, two methodologies have been used: a time-sampling method and an event-sampling method. In the time-sampling method (often called “daily-life emotion studies”), emotional events are recorded over a defined time period. In the event-sampling method, subjects are asked to remember and describe past events of a specific emotional value (ie, when subjects felt the angriest or the happiest in their lives). The time-sampling method is most often prospective, whereas the event-sampling method is retrospective. Time-sampling studies give us access to events of moderate and low emotional intensity, whereas event-sampling studies allow us to examine antecedents of extreme emotional intensity. These two approaches are therefore complementary. Besides these methodological issues, we will separately review two emotion phenomena: alexithymia and anhedonia.

Recognition and awareness of own feelings (alexithymia)

Impairments in identifying personal emotions have been described and identified in clinical groups, and they have been included in concepts like “alexithymia,” “emotion awareness,” and “emotional intelligence.” The most widely used scale to measure alexithymia has been the Toronto Alexithymia Scale.⁴³ Its 20-item revised version⁴⁴ comprises three factors: (i) difficulty identifying feelings; (ii) difficulty describing feelings; and (iii) externally oriented thinking.

Only one study used a comparison group. In this study,⁴⁵ 50 IWSs scored higher on the two factors, “difficulty identifying feelings” and “difficulty describing/communicating feelings” than NCSs.

Many questions about alexithymia remain unanswered in the general population. For example,⁴⁶⁻⁴⁹ studies on the association between alexithymia and recognition of emotions, between alexithymia and anhedonia, and

between alexithymia and negative affect have brought quite mixed results.

Event-sampling studies

In these studies, participants relate past emotional experiences. Two studies qualify as event-sampling studies in schizophrenia. One study²⁶ asked 20 IWSs, 7 patients with depression, and 8 NCSs to relate personal experiences when they felt happy, sad, and angry. Subjects were audiotaped and 50 judges rated the transcripts of the audiotapes. It is reported that there was no group effect for accuracy of affect. However, several limitations may have prevented this study from finding any group differences: only three emotions were tested; fear was not tested; all subjects were male; and the group sizes were quite small. In a recent study (Trémeau et al, unpublished data) we asked 30 IWSs and 30 NCSs (15 females in each group) to relate events when they felt very angry, disgusted, fearful, happy, sad, or surprised. Antecedents were transcribed and summarized by blind raters. Twenty judges were asked to associate the most likely emotion and, if they hesitated between emotions, the second most likely emotion that most people would feel in these circumstances. Seven choices were given: anger, disgust, fear, happiness, sadness, surprise, and neutral. The accuracy rate (agreement between judges’ ratings and emotion reported by the study subjects) was lower in the schizophrenia group, and no difference by emotion was found. However, error pattern analyses revealed a specific impairment for fear, and misattribution scores for fear correlated with the Brief Psychiatric Rating Scale (BPRS) item of suspiciousness. These results suggest impairment in the appraisal of fear in schizophrenia, and replication studies should follow.

Time-sampling studies (daily-life emotion studies)

Ecological studies are rare in schizophrenia research, even though knowing the emotional life of IWSs during their daily life is of utmost importance. Among the relevant methodologies, Delespaul developed the Experience Sampling Method.⁵⁰ In these studies, subjects are given a wristwatch that beeps randomly during the day. At each beep, the subjects are instructed to complete a set of questionnaires regarding their emotional state and their activity at that time. Usually, these studies extend over 6 days, and the watch beeps 10 times a day.

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Compared with NCSs, 88 inpatients and outpatients with schizophrenia reported more fear, and less joy and interest, in one study. In a series of studies,⁵¹ Delespaul, Myin-Germeys, and coworkers used the Experience Sampling Method to compare schizophrenia spectrum individuals to NCSs. IWSs formed from 83% to 93% of the schizophrenia spectrum group. In a first study,⁵⁰ schizophrenia spectrum individuals reported more loneliness and anxiety than NCSs, and similar degree of positive emotions (cheerfulness, satisfaction, and motivation). In subsequent studies,⁵¹⁻⁵⁶ schizophrenia spectrum individuals reported less positive affect and more negative affect. The authors also examined different kinds of stress, and they concluded that schizophrenia spectrum individuals had a higher reactivity to stress than NCSs (IWSs had a higher decrease in positive affect and a higher increase in negative affect as stress increased).

In a recent study,⁵⁷ 78 outpatients with recent-onset schizophrenia were followed for 1 year with monthly evaluations. Compared with NCSs, IWSs reported less positive and less negative events. They were also asked to rate each event they encountered. Distress appraisals did not differ between groups for positive and negative events. Compared with depressed subjects, IWSs reported less pleasure in inpatient activities. In another study,⁵⁵ currently depressed outpatients reported more negative affect and less positive affect than stable schizophrenia spectrum patients, whereas no significant differences were reported for any emotion in a previous study with chronically depressed patients (including subjects with dysthymia).

It can be concluded that IWSs report a higher degree of negative emotions and a lower degree of positive emotions occurring in their daily life than NCSs, and there is some evidence that these differences are not simply secondary to differences in life events, but may also indicate a difference in reactivity to life events.

Anhedonia (assessed with self-questionnaires)

According to Kraepelin, IWSs have difficulty experiencing pleasure. The concept of anhedonia in schizophrenia was further developed by Myerson,⁵⁸ Rado,⁵⁹ and Meehl.⁶⁰ Currently, anhedonia is considered to be a major symptom of depression and a relevant symptom in deficit schizophrenia. However, anhedonia in depression is defined as a loss of pleasure in activities that used to bring pleasure before and, as such, anhedonia is a state symptom in depression. In schizophrenia, anhedonia is

defined as an inability to experience pleasure in activities usually considered pleasurable, and as such, it is a trait symptom.

The vast majority of anhedonia studies have used the scales developed by Chapman et al⁶¹: the Physical Anhedonia Scale (PAS),⁶² the Social Anhedonia Scale (SAS), and their revised versions.

The studies are unequivocal: compared with NCSs, IWSs scored higher on the PAS (seven studies), the SAS (five studies), and a global score (one study). One study reported the same degree of social anhedonia between stable outpatients with schizophrenia and NCSs. With other anhedonia questionnaires,⁶³ similar results have been found.

Their degree of physical anhedonia,⁶³ social anhedonia,⁶³ and overall anhedonia⁶⁴ is similar to depressed subjects. Only a few studies were performed in patients off antipsychotic medications. In the first study,⁶⁵ the schizophrenia group scored high on the high infrequent item scale, questioning the validity of the answers given by these IWSs. In the second study,⁶⁶ IWSs were compared with nonschizophrenic unmedicated inpatients. When unmedicated, IWSs showed a higher PAS and similar SAS score. After an average of 2 months of treatment, the SAS score increased in the schizophrenia group, while decreasing in the psychiatric control group, and the PAS score did not change. However, in this study, no correlations between the SAS score, the PAS score, and the dosage of antipsychotic medications were found.

Several studies have focused on the status of anhedonia in schizophrenia: is it a negative symptom, a deficit symptom, a depressive symptom, or does it constitute a different dimension in psychopathology? Most studies^{15,67-71} that used correlation analyses or factor analyses were negative, and these results warn against a rapid assimilation of anhedonia as a negative or a depressive symptom. Anhedonia seems higher in deficit schizophrenia. However, these results are not surprising as decreased emotional range, curbing of interests, and diminished social drive are part of the definition of deficit schizophrenia, and consequently have some similarities in their conceptual construct.

Evocative tests

Mood induction tests have the advantage of directly controlling more or less the emotional stimuli, and consequently they allow for more direct comparison in affect

reactivity between groups. The validity of subjective reports in schizophrenia has been questioned; however, most researchers now consider that IWSs can report their subjective experiences in a valid manner.

The emotional stimuli have been quite varied: orchestral or synthetic music, photographs of facial expressions, slides from the International Affective Picture System (IAPS),⁷² video clips of movies or scenes played by actors, cartoons, odors, drinks of different tastes, words, verbal commands, reexperiencing of past situations, and social role play.

Most studies found that IWSs reported the same degree of positive emotions during all kinds of tests (25 studies). Three studies⁷³⁻⁷⁵ reported a higher degree of pleasantness, and eight studies reported lower positive feelings. For negative affect, many studies found similar degree of emotional experience between schizophrenia groups and NCS groups (21 studies). In three studies,^{11,76,77} IWSs reported feeling more negative emotions while watching unpleasant films, one study found lower unpleasantness ratings in schizophrenia, and one study reported mixed results. When subjects had to rate the degree of induced emotional arousal, IWSs rated the same degree of arousal or intensity than NCS (nine studies).

Few studies used a depression comparison group. No differences with schizophrenia groups could be found in six studies.^{15,32,78-81}

Conclusions: emotion experience

The only consensus from all studies on emotion experience is that IWSs do not experience less negative emotion than NCSs. In evocative tests and in daily-life studies, IWSs report the same degree or a higher degree of negative affect. A major discordant result concerns positive affect: anhedonia studies repeatedly showed that IWSs report less pleasure in these self-assessments, while overall they report the same level of pleasure as NCSs in evocative tests. This discrepancy awaits an explanation. Kring and Germans⁸² have looked into this issue, and have explained this discrepancy by a special deficit: IWSs “may manifest an impaired ability to anticipate the hedonic value of forthcoming pleasurable experiences.” These authors apply the distinction between appetitive pleasure and consummatory pleasure, where consummatory pleasure is the pleasure resulting from an action, and appetitive pleasure refers to the anticipation or the expectancy of a pleasurable activity. Kring’s hypothesis posits that

IWSs undervalue the pleasure they had or would have had from these circumstances. This hypothesis remains to be tested.

Perception and recognition

One hundred and ten studies examined IWSs’ ability to perceive and recognize emotions expressed by other people.

Recognition of facial emotional expressions

The stimuli have varied in several ways⁸³: still photographs versus dynamic facial expressions, posed expressions versus genuine expressions, black and white photographs versus color photographs, real faces versus drawings, real expressions versus morphed expressions (expressions created by computer), original faces versus chimeric faces (where the right hemiface shows a different emotional expression from the left hemiface), full faces versus segments of faces, exposure time of various durations, and emotional expressions of various intensities.

Many studies used Ekman and Friesen’s pictures,⁸⁴ and most often six emotions were tested (anger, disgust, fear, happiness, sadness, and surprise). Some tests have been standardized and used repeatedly, such as the Facial Emotion Identification Test (FEIT) and the Facial Emotion Discrimination Test (FEDT).⁸⁵

The procedures used in emotion recognition have not been named consistently across studies (such as “identification,” “recognition,” “labeling,” “discrimination,” “differentiation,” “matching,” “acuity,” and “attribution” tests). However, the most frequent procedures can be divided into two kinds: emotion identification and emotion discrimination. In an identification test, subjects are shown one facial expression and they have to recognize the emotion expressed. In a discrimination test, subjects are typically shown two facial expressions (at the same time or after a delay) and they have to decide whether they represent the same or different expression.

Seventy-four studies⁸⁶⁻⁸⁸ reported that IWSs or schizophrenia subgroups have deficits in facial emotion recognition when compared with NCSs, for identification, discrimination, or intensity rating, for all or some emotions tested. Eleven studies⁸⁹ found no significant differences between groups. None of these 11 studies had a sample size higher than 37. In one study,⁹⁰ paranoid-type patients

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were better than NCSs at identifying surprise and genuine negative emotions.

Five studies⁹¹ with a depression comparison group found that IWSs performed worse than depressed patients, and five other studies⁹² found no differences between these two groups. Among these last five studies, one had less than 15 subjects in each group, and in two others it seems that the depressed subjects were not depressed at the time of the study. Eight studies¹² reported mixed results. In five studies,⁸⁵ IWSs were not medicated, and they scored lower than NCSs on identification and discrimination tests. Other studies looked at correlations between performance scores and dosage of antipsychotic medications, but none found significant correlations (eight studies).¹⁶

Most studies (n=18)⁹³ could not find correlations between study performances and global measures of psychopathology and positive and negative symptoms. However, three studies⁹⁴ found significant correlations with positive symptoms, and 10 studies found some moderate correlations with negative symptoms.⁹⁵

Emotion recognition deficits correlate with multiple cognitive tests. Overall correlations have ranged between 0.30 and 0.70. The highest correlations were found for attention and vigilance. Correlations with social functioning have been investigated. It can be said that recognition deficits correlate with social skills and some functioning domains.

Acoustic tests

Rather similar designs to facial emotion recognition tests have been used for prosody recognition, including identification and discrimination tasks. Correlations between facial recognition tests and acoustic emotion tests have ranged from 0.35 to 0.70.

IWSs performed consistently worse than NCSs in identification and discrimination tests (10 studies). Three studies^{23,88,96} did not find any significant differences between groups, and a recent study⁹⁷ reported mixed results.

IWSs performed at the same level as depressed subjects in one study. In another study, IWSs could not be differentiated from depressed subjects on an identification test, but performed worse on a discrimination test.

Recognition from multiple channels

The sensory channels may combine facial expressions, bodily gestures, affective prosody, and verbal expression to var-

ious degrees. The content of the test can be an actor mimicking an emotion, actors interacting with each other, or television videoclips. The subjects are then asked to recognize the emotion portrayed or to comment on the scenes displayed. Accuracy, intensity rating, or number of emotional terms used have been the performance measures.

Overall, IWSs performed at a lower level than NCSs (11 studies). Three studies⁹⁸⁻¹⁰⁰ did not find any differences between schizophrenia group and NCSs.

No significant group differences between depression and schizophrenia were reported in two studies. In a third study,¹⁰¹ IWSs' intensity ratings were lower than depressed subjects' ratings for negative affects.

Two studies^{101,102} found significant correlations between emotion recognition deficits in multichannels and social functioning deficits.

Conclusions: perception and recognition

The only consistent results are that IWSs are impaired when compared with NCSs, and that emotion recognition correlates with cognition. It seems also clear that recognition of emotion correlates across expression channels. Other authors^{41,83,99,103,104} have reviewed studies on emotion recognition in schizophrenia, and examined specific aspects such as brain hemispheric lateralization deficits, impact on cognition and social functioning, specificity of deficits, and methodological issues.

Discussion

IWSs show dysfunctions in the three domains of emotion expression, emotion experience, and emotion recognition, and these dysfunctions seem independent of each other across domains.

In expression studies, results are convergent, and show a clear deficit in expressiveness regardless of the channel studied. They may reflect a deficit in a premotor brain area involved in social and emotional expressions such as the anterior cingulate.¹⁰⁵

Studies on emotion experience tend to show a higher frequency of negative affect and a higher sensitivity to negative conditions and stress. These results should be linked to symptoms such as paranoid ideation and persecutory delusion. Regarding positive affect, discrepant results were found between evocative studies and anhedonia studies. These differences need to be explained. Emotion experience has been linked to social motivation, and this

aspect should be further examined, as social motivation deficits seem to be a major factor in the social functioning deficits observed in schizophrenia.

Deficits in emotion recognition have been clearly identified for all channels studied. These deficits are part of the deficits in social perception, and contribute to IWSs' poor social outcomes to a certain degree.

Differences between IWSs and patients with depression are less frequent than commonly thought. In particular, deficits in emotion expression are comparable for all types of emotion expressions. This should lead to the conclusion that motor retardation described in depression and blunted affect described in schizophrenia contain the

same deficits in expressiveness. This is not to say that these deficits are entirely similar. Of course, these "shared" symptoms and deficits differ in duration and response to treatment, but this buttresses the concept that there are a limited number of syndromes in psychiatry that are shared across mental disorders.

It thus appears that emotion deficits are an important part of the psychopathology of schizophrenia. Two major recommendations can be drawn from this review: other aspects of emotion processing need to be further characterized and studied, and the consequences of these basic deficits in emotion processing on social functioning should be better understood. □

REFERENCES

1. Frijda NH. *The Emotions*. Cambridge: Cambridge University Press; 1986.
2. Scherer K. Emotion as a multicomponent process: a model and some cross-cultural data. *Rev Personality Soc Psychol*. 1984;5:37-63.
3. Ellsworth PC. Some implications of cognitive appraisal theories of emotion. In: Strongman KT, ed. *International Review of Studies on Emotion*. Chichester, UK: John Wiley & Sons; 1991:143-161.
4. Kring AM, Barrett LF, Gard DE. On the broad applicability of the affective circumplex: representations of affective knowledge among schizophrenia patients. *Psychol Sci*. 2003; 14:207-214.
5. Trémeau F, Malaspina D, Duval F, et al. Facial expressiveness in patients with schizophrenia compared to depressed patients and nonpatient comparison subjects. *Am J Psychiatry*. 2005; 162:92-101.
6. Ekman P. The argument and evidence about universals in facial expressions of emotion. In: Wagner H, Manstead A, eds. *Handbook of Social Psychophysiology*. New York, NY: John Wiley & Sons Ltd; 1989:143-164.
7. Izard CE. *The Face of Emotion*. New York, NY: Appleton-Century-Crofts; 1971.
8. Schneider F, Heimann H, Himer W, Huss D, Mattes R, Adam B. Computer-based analysis of facial action in schizophrenic and depressed patients. *Eur Arch Psychiatry Clin Neurosci*. 1990;240:67-76.
9. Berenbaum H. Posed facial expressions of emotion in schizophrenia and depression. *Psychol Med*. 1992; 22:929-937.
10. Iwase M, Yamashita K, Takahashi K, Kajim et al. Diminished facial expression despite the existence of pleasant emotional experience in schizophrenia. *Methods Find Exp Clin Pharmacol*. 1999; 21:189-194.
11. Earnst KS, Kring AM. Emotional responding in deficit and non-deficit schizophrenia. *Psychiatry Res*. 1999; 88:191-207.
12. Borod JC, Welkowitz J, Alpert M, et al. Parameters of emotional processing in neuropsychiatric disorders: conceptual issues and a battery of tests. *J Commun Disord*. 1990;23:247-271.
13. Yecker S, Borod JC, Brozgold A, Martin C, Alpert M, Welkowitz J. Lateralization of facial emotional expression in schizophrenic and depressed patients. *J Neuropsychiatry Clin Neurosci*. 1999;11:370-379.
14. Brown SL, Sweeney DR, Schwartz GE. Differences between self-reported and observed pleasure in depression and schizophrenia. *J Nerv Ment Dis*. 1979;167:410-415.
15. Berenbaum H, Oltmanns TF. Emotional experience and expression in schizophrenia and depression. *J Abnorm Psychol*. 1992; 101:37-44.
16. Gaebel W, Wolwer W. Facial expression and emotional face recognition in schizophrenia and depression. *Eur Arch Psychiatry Clin Neurosci*. 1992; 242:46-52.
17. Kring AM, Alpert M, Neale JM, Harvey PD. A multimethod, multichannel assessment of affective flattening in schizophrenia. *Psychiatry Res*. 1994;54:211-222.
18. Blanchard JJ, Kring AM, Neale JM. Flat affect in schizophrenia: a test of neuropsychological models. *Schizophr Bull*. 1994;20:311-325.
19. Aghvli MA, Blanchard JJ, Horan WP. The expression and experience of emotion in schizophrenia: a study of social interactions. *Psychiatry Res*. 2003;119:261-270.
20. Gaebel W, Wolwer W. Facial expressivity in the course of schizophrenia and depression. *Eur Arch Psychiatry Clin Neurosci*. 2004;254:335-342.
21. Scherer KR. Speech and emotional states. In: Darby JK, ed. *Speech Evaluation in Psychiatry*. New York, NY: Grune & Stratton, Inc; 1981:189-220.
22. Murphy D, Cutting J. Prosodic comprehension and expression in schizophrenia. *J Neurol Neurosurg Psychiatry*. 1990; 53:727-730.
23. Whittaker JF, Connell J, Deakin JFW. Receptive and expressive social communication in schizophrenia. *Psychopathology*. 1994;27:262-267.
24. Leentjens AF, Wielaeert SM, van Harskamp F, Wilmink FW. Disturbances of affective prosody in patients with schizophrenia; a cross sectional study. *J Neurol Neurosurg Psychiatry*. 1998;64:375-378.
25. Ross ED, Orbelo DM, Cartwright J, et al. Affective-prosodic deficits in schizophrenia: comparison to patients with brain damage and relation to schizophrenic symptoms [corrected]. *J Neurol Neurosurg Psychiatry*. 2001;70:597-604.
26. Levin S, Hall JA, Knight RA, Alpert M. Verbal and nonverbal expression of affect in speech of schizophrenic and depressed patients. *J Abnormal Psychol*. 1985;94:487-497.
27. Alpert M, Shaw RJ, Pouget ER, Lim KO. A comparison of clinical ratings with vocal acoustic measures of flat affect and alogia. *J Psychiatr Res*. 2002; 36:347-353.
28. Wolf K, Mass R, Kiefer F, et al. The influence of olanzapine on facial expression of emotions in schizophrenia - an improved facial emg study. [References]. *German J Psychiatry*. 2004;7:14-19.
29. Cacioppo JT, Bush LK, Tassinari LG. Microexpressive facial actions as a function of affective stimuli: replication and extension. *Personality Soc Psychol Bull*. 1992; 18:515-526.
30. Mattes RM, Schneider F, Heimann H, Birbaumer N. Reduced emotional response of schizophrenic patients in remission during social interaction. *Schizophr Res*. 1995;17:249-255.
31. Kring AM, Earnst KS. Nonverbal behavior in schizophrenia. In: Philippot P, ed. *Nonverbal Behavior in Clinical Settings*. New York, NY: Oxford University Press; 2003: 263-285.
32. Sison CE, Alpert M, Fudge R, Stern RM. Constricted expressiveness and psychophysiological reactivity in schizophrenia. *J Nerv Ment Dis*. 1996; 184:589-597.
33. Wolf K, Mass R, Kiefer F, et al. The influence of olanzapine versus risperidone on facial expression of emotions in schizophrenia-- preliminary results of a facial electromyogram study. [References]. *J Clin Psychopharmacol*. 2005;25:278-281.
34. Bauer RM. Physiologic measures of emotion. *J Clin Neurophysiol*. 1998;15:388-396.

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Una revisión acerca de los déficits de las emociones en la esquizofrenia

Desde los tiempos de Kraepelin han sido descritos los déficits de las emociones en la esquizofrenia. Sin embargo, nunca se ha realizado una extensa revisión acerca de estudios clínicos sobre las emociones. En este trabajo se seleccionaron, a partir de una amplia búsqueda en PubMed, estudios que utilizaran criterios diagnósticos y fueran publicados en inglés. Cincuenta y cinco estudios sobre la expresión de emociones mostraron repetidamente que individuos con esquizofrenia (ICE) presentaban menos expresiones evidentes que sujetos de comparación no pacientes en canales verbales, faciales y acústicos. No se encontraron claras diferencias entre ICE y sujetos depresivos. Sesenta y nueve estudios examinaron la experiencia emocional en la esquizofrenia. Los ICE refirieron una anhedonia más elevada y tendieron a mostrar más emociones negativas en estudios sobre acontecimientos de la vida real. En estudios de recuerdos, estos individuos refirieron un grado similar de emociones agradables, y un grado similar o mayor de emociones desagradables. A partir de 110 estudios se puede concluir que el reconocimiento de las emociones está deteriorado en la esquizofrenia en todos los canales. Estos déficits en la percepción social están correlacionados con déficits neurocognitivos y con algunas destrezas sociales. Los ICE muestran disfunción en tres propiedades de las emociones: expresión, experiencia y reconocimiento, y estas disfunciones parecen ser independientes unas de otras. Estos déficits en el procesamiento básico de las emociones podrían estar vinculados con la psicopatología y la evolución funcional.

Revue des déficits émotionnels dans la schizophrénie

Les déficits émotionnels de la schizophrénie ont été décrits depuis l'époque de Kraepelin. Cependant aucune revue complète sur les études cliniques concernant les émotions n'a jamais été menée à bien. Pour ce faire, nous avons sélectionné des études publiées en anglais et utilisant des critères diagnostiques à partir d'une large recherche sur PubMed. Dans 55 études sur l'expression des émotions, les schizophrènes ont montré à plusieurs reprises, par rapport à des sujets témoins non malades, des expressions moins extériorisées au niveau verbal, facial et acoustique. Aucune différence manifeste n'a été retrouvée entre les sujets schizophrènes et les sujets déprimés. Le vécu émotionnel de la schizophrénie a été étudié dans 69 études. Les schizophrènes font état d'une anhédonie plus importante, et ont tendance au cours des études sur les événements de vie réelle à extérioriser davantage les émotions négatives. Au cours d'études de réminiscence, ils se montrent aimables dans une même proportion et désagréables dans une proportion identique ou plus élevée. Nous pouvons conclure, à partir de 110 études, que la reconnaissance de l'émotion est détériorée dans toutes ses composantes chez les schizophrènes. Ces déficits de perception sociale sont liés à des déficits neurocognitifs et à quelques compétences sociales. Les schizophrènes présentent une dysfonction dans les trois domaines que sont l'expression de l'émotion, le vécu émotionnel et la reconnaissance de l'émotion, altérations semblant être indépendantes les unes des autres. Ces déficits des processus émotionnels de base peuvent être liés à des évolutions psychopathologiques et fonctionnelles.

35. Williams LM, Das P, Harris AW, et al. Dysregulation of arousal and amygdala-prefrontal systems in paranoid schizophrenia. *Am J Psychiatry*. 2004;161:480-489.

36. Lovallo WR, Sollers JJI. Autonomic nervous system. In: Fink G, ed. *Encyclopedia of Stress*. Academic Press, 2000:275-284.

37. Kring AM, Neale JM. Do schizophrenic patients show a disjunctive relationship among expressive, experiential, and psychophysiological components of emotion? *J Abnorm Psychol*. 1996; 105:249-257.

38. Schlenker R, Cohen R, Hopmann G. Affective modulation of the startle reflex in schizophrenic patients. *Eur Arch Psychiatry Clin Neurosci*. 1995; 245:309-318.

39. Volz M, Hamm AO, Kirsch P, Rey ER. Temporal course of emotional startle modulation in schizophrenia patients. *Int J Psychophysiol*. 2003; 49:123-137.

40. Hempel RJ, Tulen JH, van Beveren NJ, van Steenis HG, Mulder PG, Hengeveld MW. Physiological responsiveness to emotional pictures in schizophrenia. *J Psychiatr Res*. 2005; 39:509-518.

41. Mandal MK, Pandey R, Prasad AB. Facial expressions of emotions and schizophrenia: a review. *Schizophr Bull*. 1998; 24:399-412.

42. Farina A. Stigma. In: Mueser KT, Tarrrier N, eds. *Handbook of Social Functioning in Schizophrenia*. Boston, Mass: Allyn and Bacon, 1998: 247-279.

43. Taylor GJ, Ryan D, Bagby RM. Toward the development of a new self-report alexithymia scale. *Psychotherapy Psychosomatics*. 1986;44:191-199.

44. Bagby RM, Parker JD, Taylor GJ. The twenty-item Toronto Alexithymia Scale--I. Item selection and cross-validation of the factor structure. *J Psychosom Res.* 1994;38:23-32.
45. Cedro A, Kokoszka A, Popiel A, Narkiewicz-Jodko W. Alexithymia in schizophrenia: an exploratory study. *Psychol Rep.* 2001;89:95-98.
46. Prince JD, Berenbaum H. Alexithymia and hedonic capacity. *J Res Personality.* 1993;27:15-22.
47. Berenbaum H, Prince JD. Alexithymia and the interpretation of emotion-relevant information. *Cognition Emotion.* 1994;8:231-244.
48. Berenbaum H, Davis R, McGrew J. Alexithymia and the interpretation of hostile-provoking situations. *Psychother Psychosom.* 1998;67:254-258.
49. Lundh LG, Johnsson A, Sundqvist K, Olsson H. Alexithymia, memory of emotion, emotional awareness, and perfectionism. *Emotion.* 2002;2:361-379.
50. Delespaul PAEG. *Assessing Schizophrenia in Daily Life. The Experience Sampling Method.* Maastricht, the Netherlands: Universitaire Pers Maastricht; 1995.
51. Myin-Germeys I, van Os J, Schwartz JE, Stone AA, Delespaul PA. Emotional reactivity to daily life stress in psychosis. *Arch Gen Psychiatry.* 2001; 58:1137-1144.
52. Myin-Germeys I, Krabbendam L, Jolles J, Delespaul PA, van Os J. Are cognitive impairments associated with sensitivity to stress in schizophrenia? An experience sampling study. *Am J Psychiatry.* 2002;159:443-449.
53. Myin-Germeys I, Delespaul P, van Os J. Behavioural sensitization to daily life stress in psychosis. *Psychol Med.* 2005;35:733-741.
54. Myin-Germeys I, Krabbendam L, Delespaul PA, van Os J. Do life events have their effect on psychosis by influencing the emotional reactivity to daily life stress? *Psychol Med.* 2003;33:327-333.
55. Myin-Germeys I, Peeters F, Havermans R, Nicolson NA, DeVries MW, Delespaul P et al. Emotional reactivity to daily life stress in psychosis and affective disorder: an experience sampling study. *Acta Psychiatr Scand.* 2003; 107:124-131.
56. Myin-Germeys I, Delespaul PA, DeVries MW. Schizophrenia patients are more emotionally active than is assumed based on their behavior. *Schizophr Bull.* 2000;26:847-854.
57. Horan WP, Ventura J, Nuechterlein KH, Subotnik KL, Hwang SS, Mintz J. Stressful life events in recent-onset schizophrenia: reduced frequencies and altered subjective appraisals. *Schizophr Res.* 2005;75:363-374.
58. Meyerson A. Anhedonia. *Am J Psychiatry.* 1923;2:87-123.
59. Rado S. *Psychoanalysis and Behavior: the Collected Papers of Sandor Rado.* New York, NY: Grune & Stratton; 1962.
60. Meehl PE. Schizotypality, schizotypy, schizophrenia. *Am Psychol.* 1962;17:827-838.
61. Chapman LJ, Chapman JP, Raulin ML. Scales for physical and social anhedonia. *J Abnorm Psychol.* 1976;85:374-382.
62. Holt DJ, Kunkel L, Weiss AP, et al. Increased medial temporal lobe activation during the passive viewing of emotional and neutral facial expressions in schizophrenia. *Schizophr Res.* 2005; Dec 22. [Epub ahead of print]
63. Herbener ES, Harrow M, Hill SK. Change in the relationship between anhedonia and functional deficits over a 20-year period in individuals with schizophrenia. *Schizophr Res.* 2005;75:97-105.
64. Whitty P, Browne S, Clarke M, et al. Systematic comparison of subjective and objective measures of quality of life at 4-year follow-up subsequent to a first episode of psychosis. *J Nerv Ment Dis.* 2004;192:805-809.
65. Franke P, Maier W, Hardt J, Hain C, Cornblatt BA. Attentional abilities and measures of schizotypy: their variation and covariation in schizophrenic patients, their siblings, and normal control subjects. *Psychiatry Res.* 1994;54:259-272.
66. Lewine RRJ. Anhedonia and the amotivational state of schizophrenia. In: Marneros A, Andreasen NC, Tsuang MT, eds. *Negative versus Positive Schizophrenia.* Berlin, Germany: Springer-Verlag; 1991:79-95.
67. Loas G, Boyer P, Legrand A. Anhedonia and negative symptomatology in chronic schizophrenia. *Compr Psychiatry.* 1996;7:5-11.
68. Loas G, Noisette C, Legrand A, Boyer P. Is anhedonia a specific dimension in chronic schizophrenia? *Schizophr Bull.* 2000;26:495-506.
69. Blanchard JJ, Bellack AS, Mueser KT. Affective and social-behavioral correlates of physical and social anhedonia in schizophrenia. *J Abnorm Psychol.* 1994;103:719-728.
70. Silver H, Shlomo N. Anhedonia and schizophrenia: how much is in the eye of the beholder? *Compr Psychiatry.* 2002;43:165-68.
71. Romney DM, Candido CL. Anhedonia in depression and schizophrenia: a reexamination. *J Nerv Ment Dis.* 2001;189:735-740.
72. *The International Affective Pictures System.* [IAP: photographic slides]. Gainesville, FL: University of Florida; 1999.
73. Kring AM, Kerr SL, Smith DA, Neale JM. Flat affect in schizophrenia does not reflect diminished subjective experience of emotion. *J Abnorm Psychol.* 1993;102:507-517.
74. Rupp CI, Fleischhacker WW, Kemmler G, et al. Various bilateral olfactory deficits in male patients with schizophrenia. *Schizophr Bull.* 2005;31:155-165.
75. Doop ML, Park S. On knowing and judging smells: Identification and hedonic judgment of odors in schizophrenia. *Schizophr Res.* 2006;81:317-319.
76. Salem JE, Kring AM. Flat affect and social skills in schizophrenia: evidence for their independence. *Psychiatry Res.* 1999;87:159-167.
77. Kring AM, Earnst KS. Stability of emotional responding in schizophrenia. *Behavior Therapy.* 1999;30:373-388.
78. Nielzén S, Cesarec Z. The effect of mental illness on the emotional experience of music. *Arch Psychiatr Nervenkr.* 1982;231:527-538.
79. Nielzén S, Cesarec Z. Emotional experience of music by psychiatric patients compared with normal subjects. *Acta Psychiatr Scand.* 1982;65:450-460.
80. Heimberg C, Gur RE, Erwin RJ, Shtasel DL, Gur RC. Facial emotion discrimination: III. Behavioral findings in schizophrenia. *Psychiatry Res.* 1992;42:253-265.
81. Weniger G, Lange C, Ruther E, Irle E. Differential impairments of facial affect recognition in schizophrenia subtypes and major depression. *Psychiatry Res.* 2004;128:135-146.
82. Kring AM, Germans MK. Subjective experience of emotion in schizophrenia. In: Jenkins JH, Barrett RJ, eds. *The Edge of Experience: Schizophrenia, Culture, and Subjectivity.* New York, NY: Cambridge University Press, 2004; 329-348.
83. Edwards J, Jackson HJ, Pattison PE. Emotion recognition via facial expression and affective prosody in schizophrenia: a methodological review. *Clin Psychol Rev.* 2002;22:789-832.
84. *Pictures of Facial Affect.* Palo Alto, CA: Consulting Psychologist's Press; 1976.
85. Kerr SL, Neale JM. Emotion perception in schizophrenia: specific deficit or further evidence of generalized poor performance? *J Abnorm Psychol.* 1993;102:312-318.
86. van der Gaag M, Haenene MA. Schizophrenia and the impaired evaluation of facial affect. In: Drenth PJD, Sergeant JA, Takens RJ, eds. *European Perspectives in Psychology.* Chichester, UK: John Wiley & Sons; 1990:81-89.
87. Habel U, Gur RC, Mandal MK, Salloum JB, Gur RE, Schneider F. Emotional processing in schizophrenia across cultures: standardized measures of discrimination and experience. *Schizophr Res.* 2000;42:57-66.
88. Kee KS, Horan WP, Mintz J, Green MF. Do the siblings of schizophrenia patients demonstrate affect perception deficits? *Schizophr Res.* 2004;67:87-94.
89. Ellgring H, Gaebel W. Facial expression in schizophrenic patients. In: Beigel A, Lopez Ibor JJ Jr, Costa e Silva JA, eds. *Past, Present, and Future of Psychiatry.* London, UK: World Scientific Publishers; 1994:435-439.
90. Davis PJ, Gibson MG. Recognition of posed and genuine facial expressions of emotion in paranoid and nonparanoid schizophrenia. *J Abnorm Psychol.* 2000;109:445-450.
91. Feinberg TE, Rifkin A, Schaffer C, Walker E. Facial discrimination and emotional recognition in schizophrenia and affective disorders. *Arch Gen Psychiatry.* 1986;43:276-279.
92. Flack WF, Jr, Cavallaro LA, Laird JD, Miller DR. Accurate encoding and decoding of emotional facial expressions in schizophrenia. *Psychiatry.* 1997;60:197-210.
93. Kee KS, Kern RS, Marshall BD, Jr, Green MF. Risperidone versus haloperidol for perception of emotion in treatment-resistant schizophrenia: preliminary findings. *Schizophr Res.* 1998;31:159-165.
94. Leitman DI, Foxe JJ, Butler PD, Saperstein A, Revheim N, Javitt DC. Sensory contributions to impaired prosodic processing in schizophrenia. *Biol Psychiatry.* 2005;58:56-61.
95. Kohler CG, Turner TH, Bilker WB, et al. Facial emotion recognition in schizophrenia: intensity effects and error pattern. *Am J Psychiatry.* 2003;160:1768-1774.
96. Edwards J, Pattison PE, Jackson HJ, Wales RJ. Facial affect and affective

Clinical research

prosody recognition in first-episode schizophrenia. *Schizophr Res.* 2001;48:235-253.

97. Rossell SL, Boundy CL. Are auditory-verbal hallucinations associated with auditory affective processing deficits? *Schizophr Res.* 2005;78:95-106.

98. Colussy SA, Zuroff DC. Schizophrenic and depressed inpatients' perceptions of congruent and incongruent communications. *J Clin Psychol.* 1985;41:331-337.

99. Morrison RL, Bellack AS, Mueser KT. Deficits in facial-affect recognition and schizophrenia. *Schizophr Bull.* 1988;14:67-83.

100. Joseph PL, Sturgeon DA, Leff J. The perception of emotion by schizophrenic patients. *Br J Psychiatry.* 1992;161:603-609.

101. Bellack AS, Mueser KT, Wade J, Sayers S, Morrison RL. The ability of

schizophrenics to perceive and cope with negative affect. *Br J Psychiatry.* 1992;160:473-480.

102. Toomey R, Wallace CJ, Corrigan PW, Schuldberg D, Green MF. Social processing correlates of nonverbal social perception in schizophrenia. *Psychiatry.* 1997;60:292-300.

103. Hellewell JS, Whittaker JF. Affect perception and social knowledge in schizophrenia. In: Mueser KT, Tarrier N, eds. *Handbook of Social Functioning in Schizophrenia.* Needham Heights, MA: Allyn & Bacon; 1998:197-212.

104. Kohler CG, Turner TH, Gur RE, Gur RC. Recognition of facial emotions in neuropsychiatric disorders. *CNS Spectr.* 2004;9:267-274.

105. Devinsky O, Morrell MJ, Vogt BA. Contributions of anterior cingulate cortex to behaviour. *Brain.* 1995; 118 (pt 1):279-306.